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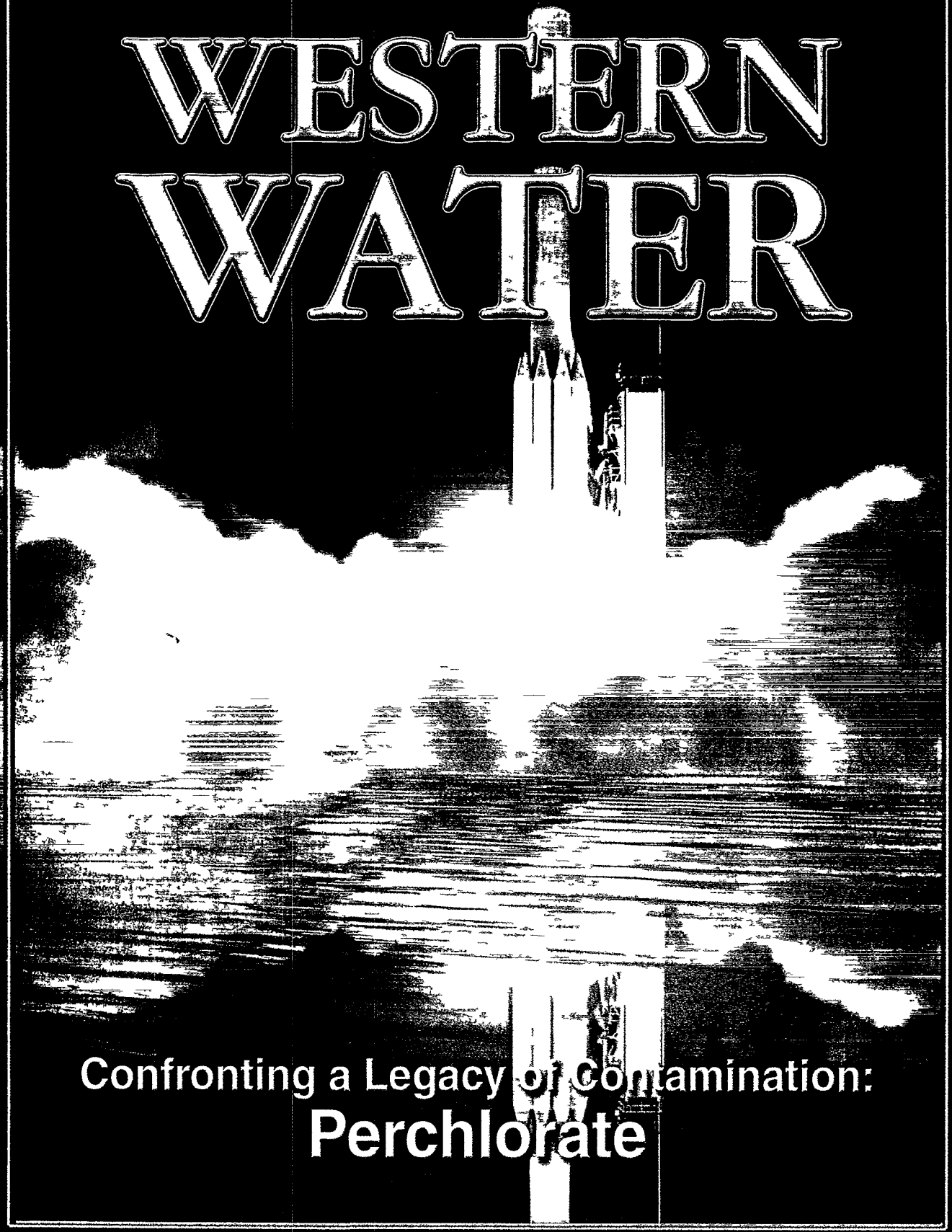
May / June 2003

WESTERN WATER



Confronting a Legacy of Contamination: Perchlorate

Published by the Water Education Foundation

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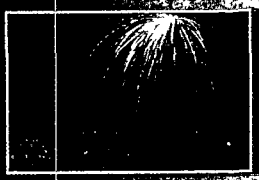

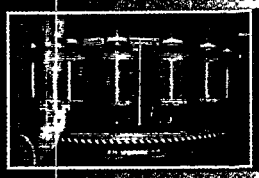

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Water contamination is most commonly
th solid rocket fuel.
Illustration by Curtis Leipold

dits

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Editor's Desk

"State of Denial" is the name of a special section recently published by the local Sacramento newspaper. The writer discusses how California's environmental legacy of conserving resources at home is setting us on a collision course with its habit of consuming resources from abroad in record quantities. And often, he notes, the losers are impoverished citizens and communities – and their own spectacular ecosystems – in the remotest parts of the globe where the quest for money to survive is often more important than preserving the resources.

The author, *Sacramento Bee* reporter Tom Knudson, is a Pulitzer Prize winning reporter and he profiles several California lifestyles in terms of ecological footprints – the measure of our impact on the world and the area required to produce the resources consumed and absorb the wastes generated by each person. (You can determine your own ecological footprint at: www.myfootprint.org.) The national average is 24 acres, but most Westerners (and Californians) rate a higher number. My footprint is about 30. According to this think tank, we would need about 7 planets if everyone on earth lived as me and my family. (We commute to work, mostly by car; we travel by air at least a couple of times a month and have a rich and diverse diet.)

The idea of "footprints" relates to this issue of *Western Water*. Our use of chemicals created in World War II and used into the Space Age has left a heavy footprint on our nation. In the West, large pockets of groundwater are tainted by a wide array of chemicals, many manmade, that threaten the integrity of local water supplies and the ability of agencies to provide communities with safe, reliable water service. In this issue, Writer Gary Pitzer takes a look at the footprint one particular chemical – perchlorate – has made in California and Nevada. As Gary explains in this article, much of the perchlorate contamination deals from past disposal practices in which wastewater containing perchlorate was simply allowed to drain directly into the ground.

"Prevention, prevention, prevention" is the common mantra chanted by most groundwater experts today – especially in light of the expensive and extensive efforts underway to treat the contamination caused, at many places, by past practices. The importance of this fact is that we need to learn from past mistakes. That's where the Water Education Foundation can help. Our low-cost, easily understood materials help everyone, from K-12 students to the newspaper reporter to water district customers, understand what groundwater is, how it is connected to the surface of the land (and to surface water) and how to protect it from future contamination. See page 15 for a partial list of our groundwater and water quality materials, which include videos, guides, maps, school programs, and much, much more – including an Oct. 15-17 Southern California Groundwater Tour.

Groundwater is a hidden resource, and it is important to help the public understand that underneath the ecological footprint is a source of water that supplies, statewide, some 30 percent of our annual water with some communities 100 percent reliant upon this underground water. It is vital that we use this resource wisely, and strive to protect it from pollution. ❖

Rita Schmidt Sudman

See page 14 for more on WEF's latest activities, or visit our web site at www.watereducation.org

In the News

Judge OKs Extra Trinity Flows to Ease Burden on Lower Klamath River

Seeking to avoid the conditions that may have contributed to the deaths of thousands of salmon in the Lower Klamath River last summer, a federal judge has ordered that extra water be released into the Trinity River to help boost Lower Klamath flows. The rivers meet about 40 miles upstream from the Pacific Ocean in prime spawning habitat.

The decision was made after U.S. Fish & Wildlife Service biologists cautioned that a similar disaster could be in the making because of continued drought in the Klamath Basin.

U.S. District Court Judge Oliver Wanger April 7 ruled that 453,000 acre-feet of water be released from the Trinity and Lewiston dams to protect salmon migrating upstream. In addition, 50,000 acre-feet of water could be available, if necessary. An estimated 33,000 salmon died on the Lower Klamath last summer. Opinions are mixed as to why the die-off occurred, with the California Department of Fish and Game citing insufficient flows.

Meanwhile, farmers served by the Klamath Project will receive near-normal water supplies this year, the U.S. Bureau of Reclamation (Bureau) announced. The region is again feeling the impact of a drier-than-normal winter, meaning that 299,000 acre-feet of water will be available, about 7 percent less than the 323,000 acre-feet delivered in past dry years.

In issuing its annual Klamath Project Operations Plan, the Bureau classified the water year as "dry." Buttressing the plan is a temporary water bank in which willing farmers are paid to fallow fields in order to limit diversions. "The combination of the water bank, efficient water management and some help from Mother Nature will all be needed to get us through this hole," said Dan Keppen, executive director of the Klamath Water Users Association.

Critics of the region's water management say the problem of overallocation has yet to be properly addressed. "What is most disappointing is that in spite of years now of ongoing federal water crises throughout the basin, so little has changed," said Glen Spain with the Pacific Coast Federation of Fishermen's Associations (PCFFA). "Federal mismanagement put both farmers and fishermen in this mess by promising too many irrigators water that was never really there."

PCFFA is the lead plaintiff in a federal case that alleges the Bureau is violating the Endangered Species Act by not releasing enough water from Iron Gate Dam on the Upper Klamath. A hearing before Wanger was scheduled for April 29.

Citing the water woes of the Klamath, a conservation group named the river as the second most endangered in the country. "The Klamath River and its fisheries are the real victims when too much irrigation demand chases little water," said Rebecca Wodder, president of American Rivers, which recently issued its annual list of the top 10 endangered rivers. "These chronic water shortages in the river are compounded by the hydropower dams that block many miles of salmon spawning habitat."

U.S. Reps. Mike Thompson, D-Calif., and Earl Blumenauer, D-Ore., have introduced the Klamath River Basin Restoration & Emergency Assistance Act, which would provide $200 million for water conservation and economic assistance for communities affected by last year's fish kill. ❖

Where We Are:

May 6
WEF Board of Directors Meeting
Henry J. Vaux, Jr., President
Sacramento, CA

May 7-8
WEF Exhibit booth
Association of California Water Agencies
South Lake Tahoe, CA

May 10
Watershed Symposium
Judy Maben, Speaker
Center High School
Sacramento, CA

May 14-16
WEF Central Valley Tour
Judy Maben, Tour Coordinator
Sacramento, CA

May 28 – June 1
National Project WET Conference
Judy Maben, CA WET Coordinator
Judy Knott, CA WET Assistant Coordinator
Clemson, SC

June 4-6
WEF Bay Delta Tour
Judy Maben, Tour Coordinator
Sacramento, CA

June 12-14
Water for People Board Meeting
Rita Schmidt Sudman, Board Member
Anaheim, CA

June 13
Project WET Workshop
Judy Maben, CA WET Coordinator
Mojave Water District
Apple Valley, CA

July 17-18
WEF Water Law & Policy Briefing
Rita Schmidt Sudman and Steve McClung, Coordinators
San Diego, CA

Confronting a Legacy of Contamination: Perchlorate

by Gary Pitzer

There's danger lurking underground. The threat cannot be seen, heard or felt immediately, but there it resides – in shallow pockets of groundwater and deep, cold subterranean aquifers situated hundreds of feet below the surface. The danger manifests itself through the most vital human activity next to breathing, the consumption of water. Experts know there is no such thing as pure water. Microscopic bits of a host of elements that surround us are present in the water we drink. They exist at levels that are harmless, and in fact some of the constituents found in tap water are beneficial to human health.

But large pockets of groundwater today are tainted by an array of chemicals, some manmade, some naturally occurring, that threaten the integrity of supplies and the ability of agencies to provide safe, reliable service. In some cases, the chemicals are the remnants of long-dormant industrial and military operations conducted during a time of ignorance or indifference to the environmental impacts of careless handling and disposal. Other chemicals, such as the notorious methyl tertiary butyl ether (MTBE), are the unintended result of environmental policy enacted without enough cross-media analysis.

The wave of contaminants bear scientific-sounding names such as nitrate and chromium, or arranged into alphabet soup acronyms such as the aforementioned MTBE, TCE or PCE. Often, the sheer volume of contamination caused by decades of seepage presents regulators and responsible parties with a gargantuan task of cleanup and restoration. The amount of money spent nationwide for such an effort amounts to billions of dollars. Water sources have been cleaned to remarkable levels. Restoring eroded public confidence, however, has not always been so easy. Consumers hesitant about the quality of the water flowing from the kitchen faucet have turned to bottled water in growing numbers.

Taking its place as the contaminant *du jour* is perchlorate, a chemical most associated with solid rocket fuel that has been appearing with alarming frequency in sites nationwide. Like MTBE, perchlorate moves rapidly through water and soil and consequently is the fastest-growing contaminant in California's groundwater. Thanks to improved detection technology, decades of groundwater pollution are slowly being uncovered as underground plumes have shut down or threatened to shut down dozens of wells up and down California. Meanwhile, across the border in Nevada, an underground swell of perchlorate slowly percolates into Lake Mead and the Colorado River, threatening the supply for millions of people dependent on the river for drinking water.

"It's turned into much more than any of us expected," said Kevin Mayer, Superfund project manager with the U.S. Environmental Protection Agency (EPA) Region IX in San Francisco. "It's gone from a fairly localized release of a pretty unusual and specialized chemical to finding it in ... many public water systems."

Perchlorate's presence in the environment has been known about for decades, but it was only fairly recently that technological develop-

ments enabled its discovery in groundwater at the parts-per-billion (ppb) level. Such infinitesimal measurements are nearly incomprehensible given that one ppb is equivalent to a grain of sand in an Olympic-sized swimming pool.

Among the many chemicals that contaminate groundwater, perchlorate is particularly vexing because of its persistence and high solubility. Experts say that were it not for the threat posed to human health and the environment, perchlorate would be a good tool to track the movement of subsurface water.

"Perchlorate would be an ideal tracer if it didn't have the toxicity," Mayer said. "It stays in a solution without being attracted to soil or organic elements and moves as rapidly as water itself."

The discovery of perchlorate in groundwater has moved beyond areas that were hubs of rocket engine production during the era of the Cold War and the early years of space exploration. Subsequent investigation has revealed contamination in and around facilities tied to the production of fireworks and even the charges used to deploy airbags in motor vehicles.

"What's happened in the last two and a half years is that we now know that it's not just a question of localized drinking water contamination," said Bill Walker, West Coast vice president of Environmental Working Group (EWG). "We're not at the end of the curve in discovering where the end of the problem is."

Some say perchlorate's presence has been overshadowed by MTBE, which became such a headache because of its propensity to contaminate groundwater. Authorized by the state as a way to ensure cleaner-burning gasoline, the chemical was eventually ordered out of California gasoline through an executive order by Gov. Gray Davis. Larry Ladd, a medical geographer involved with perchlorate at the Aerojet facility in Rancho Cordova, said he's been frustrated by the relative lack of attention given to the rocket fuel oxidizer.

"Perchlorate and MTBE started out at the same time, but perchlorate keeps getting put on the back burner," he said. "MTBE isn't very much of a health threat because people can taste it in the water at 5 ppb."

Yet recent headlines suggest perchlorate is getting more attention. In southern California, home to the aerospace industry, regulators, local officials and residents are grappling with plumes near Simi Valley, in San Gabriel Valley and in the Inland Empire region. The problem has spurred a sometimes contentious process of identifying responsible parties and negotiating the terms by which cleanup will proceed.

"It's a horrendously complicated issue in terms of the origin of contamination and who's responsible," said Mic Stewart, water quality section manager for the Metropolitan Water District of Southern California (MWD).

Meanwhile, in the northern California communities of Morgan Hill and San Martin, perchlorate contamination traced to a highway safety flare manufacturing plant has shut down several drinking water wells and frayed the nerves of outlying residents dependent on private wells. The Santa Clara Valley Water District has responded with free well testing and bottled water while efforts are made to confirm the extent of the plume.

As more reports of perchlorate in drinking water appear, scientists continue to study the chemical's impact on the human body, including sensitive subpopulations – people for which ingestion poses unique health problems. Perchlorate is presently classified as an unregulated contaminant for which monitoring is required. Over time, estimates of an acceptable level in drinking water have steadily descended from 18 ppb in 2000 to the few parts per billion that could be settled upon by EPA and state health departments.

Perchlorate disrupts the proper function of the thyroid gland by

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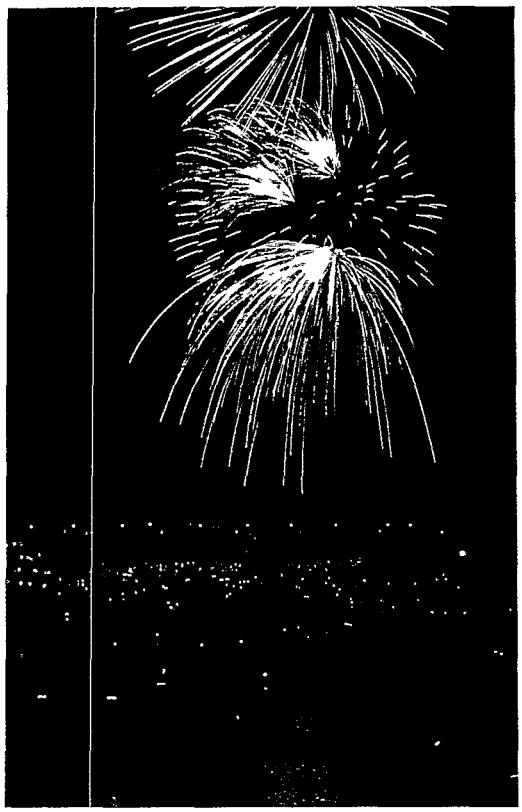
– Mic Stewart
Metropolitan Water District of Southern California



Ammonium perchlorate is used in the manufacture of some fireworks.

blocking iodide uptake. The thyroid gland plays a sort of traffic cop role in the human body, regulating the release of hormones for growth, development and metabolism. Ironically, doctors once prescribed perchlorate to treat hyperthyroidism. While an iodide-deficient thyroid gland in adults can cause relatively moderate impacts such as fatigue, depression, weight gain and hair loss, it is perchlorate's effect on developing fetuses and children that has prompted the most concern among public health officials and advocacy groups such as EWG. The organization suggests the drinking water standard be set at 1 ppb.

"There are understandable disagreements on how to define a safe dosage because a lot of this involves estimates and uncertainties," Mayer said.

Part of the disagreement comes from the Department of Defense, which believes EPA has overestimated the risk posed by perchlorate while overlooking some human health data.

The final drinking water standard for perchlorate set by the state of California will be based on protective health criteria as well as technological and economical feasibility. Drinking water providers are keenly focused on the costs associated with the limits on perchlorate, given the expense of removing perchlorate from water. Agency officials already have encountered those ramifications in areas where wells taken out of service seriously hamper water delivery.

"The reliability of the local water supply is in jeopardy [and] without immediate action ... we face the prospect of a clear and present public safety crisis this summer," said Michael Whitehead, a member of the Chino Basin Watermaster Authority, at a Senate select committee hearing in January.

Whitehead received a sympathetic response by lawmakers anxious to deal with the problem, including State Sen. Nell Soto, D-Pomona, who called the wholesale contamination of aquifers the "single greatest threat to our economic stability." State Sen. Mike Machado, D-Linden, described perchlorate as "a public health issue, an environmental issue and ultimately, a quality of life issue."

This issue of *Western Water* examines the problem of perchlorate contamination and its ramifications on all facets of water delivery, from the extensive cleanup costs to the search for alternative water supplies. In addition to discussing the threat posed by high levels of perchlorate in drinking water, the article presents examples of areas hard hit by contamination and analyzes the potential impacts of forthcoming drinking water standards for perchlorate.

Background

Perchlorate is the catchall name for the solid salts of ammonium, potassium and sodium perchlorate. Ammonium perchlorate, which accounts for 90 percent of all production, acts as an energy-booster in solid rocket fuel. Ammonium perchlorate is also used in certain fireworks, the manufacture of matches and for the process of air bag deployment. The rubber binder that holds the solid rocket fuel in place has a limited shelf life and must be regularly replaced. As a result, large volumes of perchlorate have been disposed of since the 1940s, leading to widespread contamination in California, Nevada, Utah and other states.

"We're being surprised continuously at the level it's being found," Mayer said. "At this point, we're at the place where information is growing quite rapidly."

The volume of disposed perchlorate is impressive, given the amount present in rocket engines. According to NASA, each solid rocket booster on the space shuttle contains 700,000 pounds of perchlorate, for a total of nearly 1.5 million pounds. In years past, it was disposed of by flushing with high-pressure water jets – a process that resulted in wastewater with perchlorate levels at 1 percent of total volume. Often, the water was simply drained directly into the ground.

"No one can say for certain how many million pounds of perchlorate have been heedlessly flushed into the environment during the last half-century," states a 2001 EWG report, *Rocket Science*. "Considering the amount of the chemical necessary to be detectable in Lake Mead and in the Colorado River, the volume of perchlorate waste must be vast."

James Hunt, professor of civil and environmental engineering at the University of California, Berkeley, said that because perchlorate has been used as a concentrated salt in the manufacturing process, waste discharges were concentrated brines that sink into pockets of groundwater and remain there indefinitely.

Although awareness of perchlorate in groundwater was evident as early as the 1950s, cleanup did not proceed for various reasons – from higher priority contaminants to ignorance of the threat posed to indifference by state

and federal regulators. In fact, during the cleanup process of other chemicals, which included groundwater extraction, treatment and reinjection, perchlorate-tainted water was actually put into groundwater pockets previously uncontaminated.

In 1985, detection was made in the range of 110 ppb to 2,600 ppb near the Aerojet manufacturing facility in the San Gabriel Valley. Scientific consultation on the gravity of the contamination concluded that while the perchlorate levels probably did not pose an acute threat to public health, the ramifications of low-level consumption merited study. Regulators believed there was the potential for interference from nitrate in the analyses because the analytical method at that time apparently could show false positives for perchlorate due to the presence of nitrate.

In 1997, the California Department of Health Services (DHS) developed a new method that enabled perchlorate detection to occur at concentrations as low as 4 ppb. Shortly afterward, public water agencies began routine sampling. During the past five years, perchlorate has been detected in 315 drinking water sources covering 83 water systems statewide. Leading the pack is Los Angeles County, with 126 sources covering 37 water systems.

Removing perchlorate from water is primarily done through ion exchange, a process by which the chemical is absorbed onto resin with an affinity for perchlorate as water passes through the resin-filled vessels. Other treatments such as air stripping and carbon filtration, which are used to remove volatile organic chemicals, are not effective methods because the salt does not evaporate nor does it have a strong affinity to bind with carbon, said the EPA's Mayer.

"It's not as pervasive as VOC contamination, but it's a significant problem because of the high cost of treatment," said Carol Williams, executive officer of the Main San Gabriel Basin Watermaster. Current removal costs run from $200 to $300 per acre-foot, "which is pretty hefty considering the low levels of perchlorate that are being treated," she said.

Health Effects/Proposed Standards

Perchlorate's impact on human health is felt primarily on the group that is the most unable to take preventive measures – the unborn. Activists such as EWG say that is of concern because small changes in maternal thyroid hormones during pregnancy are associated with reduced intelligence levels and attention deficit disorder in children. Larger changes can result in mental retardation, loss of hearing and speech or deficits in motor skills, according to EWG.

Because the thyroid gland begins to function at the end of the first trimester of pregnancy, altered iodide uptake can have irreversible effects on the fetus. "The problem is, *in utero* exposure to perchlorate can interfere with normal brain development," said Steven Book, chief of the monitoring and evaluation unit within DHS' drinking water program. "Once that happens, you don't get to go back and revisit it."

Scientists did not begin to analyze the possible health effects of perchlorate at low doses until the late 1990s. EPA, which has not determined whether to set a national drinking water standard, has an interim guidance of 4 ppb to18 ppb, which was established between 1992 and 1995. Mayer said there are "multiple components" that determine the extent of perchlorate's threat to public health, such as level of toxicity, the dosage that prompts a health concern and the number of people exposed to contaminated water.

"We've not finalized the toxicity assessment, but the arguments say 1 to 10 to 20 ppb is safe," he said. "Others suggest that more than 100 ppb is protective."

The agency does not expect to have an enforceable standard in place until at least 2007. Earlier this year,

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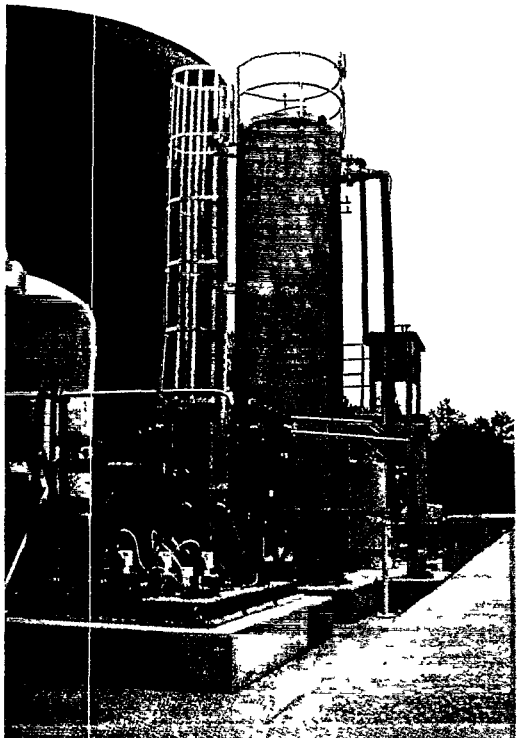


"There's a lot of looking at treatment technologies, and some water systems are getting money to build treatment systems. There's a lot of monitoring going on."

– Steven Book
California Department of Health Services

EPA reaffirmed the validity of its interim guidance for perchlorate, with the caveat that authorities "carefully consider the low end" of the 4-18 ppb range. EWG, which two years ago advocated a drinking water level of no more than 4.3 ppb, today urges an even stricter level of 0.1 ppb.

"Our review of the latest literature indicates the more they study it, they find even more harmful health effects," Walker said. He added that concerns also have been raised about the possible adverse health effects of consuming lettuce and other produce grown with perchlorate-tainted water. Book agreed that additional research is needed on what the uptake of different food sources might be, as well as the ecological effects on fish, birds and wildlife.

Book disputed the notion that perchlorate has been pushed back in priority to other groundwater pollutants. "It's not like it's totally being ignored," he said. "There's a lot of looking at treatment technologies, and some water systems are getting money to build treatment systems. There's a lot of monitoring going on."

Scientific data on perchlorate varies, given the parameters of the research conducted. In one instance, school-age children and newborns in northern Chile were studied for potential health effects from consuming perchlorate in drinking water. Naturally occurring concentrations of perchlorate in the Chilean environment translate into drinking water levels ranging from five to 100 parts per billion.

According to the study, which was published in the June 2000 *Journal of Occupational and Environmental Medicine*, "no evidence was found that perchlorate in drinking water at these concentrations is associated with thyroid suppression in newborns or school-age children. Among school-age children, no evidence was found of adverse effects on thyroid function."

Perchlorate "appears to be not a very bad actor at concentrations of 100 [ppb] or less," said Errol Montgomery, a Tucson-based hydrogeologist who participated in the study. The Kerr-McGee Chemical Corp., a perchlorate manufacturer, provided funding for the study.

Ladd said the relative threat posed by perchlorate "is greater than MTBE," and that it is probably the chronic exposure to the chemical that is of the most concern. "My sense is that since people are drinking large amounts [and] not dropping like flies [that] it's more an issue of its effect on the people who tend to be sensitive."

In California, efforts are underway to establish a drinking water standard, called a maximum contaminant level (MCL), by the beginning of 2004. The state Office of Environmental Health Hazard Assessment (OEHHA) was to have set an advisory public health goal (PHG) by the beginning of 2003, but challenges to the methodology used for the PHG pushed that process to the point where the final PHG was not expected until mid-2003. The PHG, defined as the level of a chemical contaminant in drinking water that does not pose a significant risk to health, will be an exact number within the range of 2-6 ppb, said Allan Hirsch, deputy director of external and legislative affairs at OEHHA.

The PHG is the basis for the MCL, which is overseen by DHS. The agency's present action level of 4 ppb means that when it is exceeded, a water system is required to notify local governing agencies and is recommended to issue a consumer notice. Using a 10-fold safety factor, officials recommend that contaminated wells be taken out of service at detection levels of 40 ppb perchlorate.

EWG has criticized the criteria for OEHHA's PHG, saying the agency "relies solely on the results" of an industry-funded human study and uses an inadequate uncertainty factor. The term accounts for physical differences between people, short-term vs. long-term exposure, extrapolation from study population to the population of concern and whether perchlorate concentrates in breast milk.

Hirsch said the uncertainty factor used by OEHHA is valid and that the PHG for perchlorate differs from those for other chemicals, which have a more severe health effect such as cancer.

"It is important to understand that it takes quite a bit of inhibition of iodide uptake to affect the production and release of thyroid hormones, and it would also take a relatively significant disruption of thyroid hormones to affect the fetus," he said. "The difference between the perchlorate exposure needed to affect thyroid iodide uptake and the exposure needed to ... affect the fetus can be thought of as an additional safety, beyond the official uncertainty factor ... that we used."

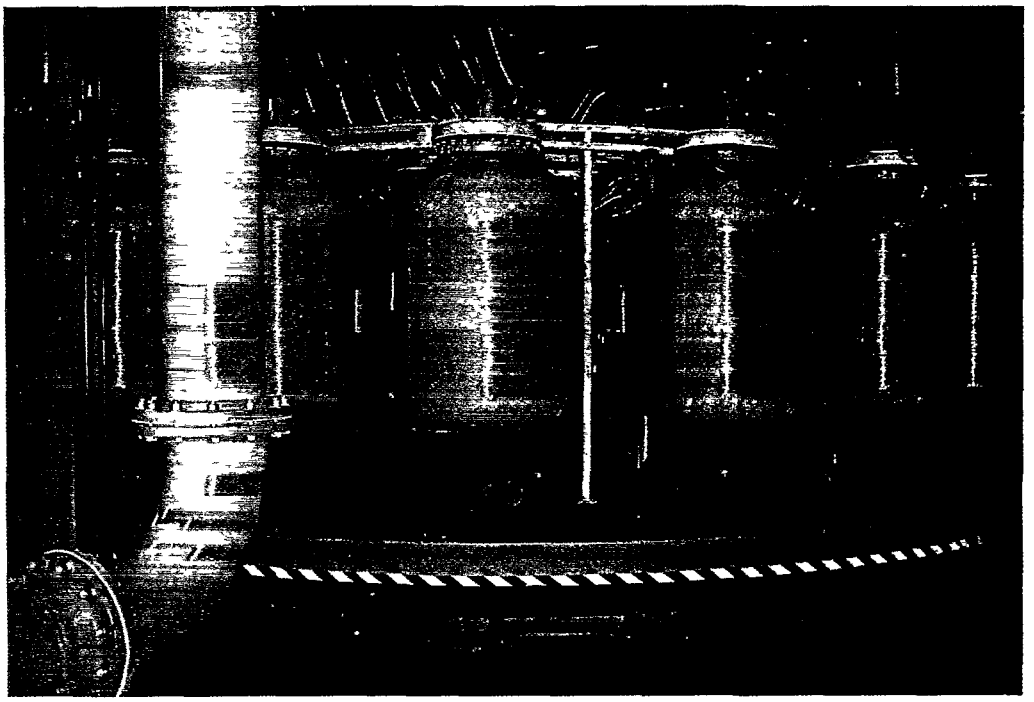
What the acceptable level of perchlorate in drinking water should be varies depending on perspective. Col. Richard Thompson with the U.S. Army Corps of Engineers (Corps) told state lawmakers that the Pentagon has not established a cleanup standard for perchlorate and that 4 ppb "would have to be addressed on a site-specific level." Defense officials have suggested that perchlorate is safe in drinking water at levels as high as 200 ppb.

"I'm not too concerned about the effect on adults," said Janis Hulla, senior toxicologist with the Corps in Sacramento. "There's a difference between the effects on adults and the effects on neurological development so my greatest concern is for the developing fetus."

Because perchlorate's potential harm is strictly tied to its dosage, "at some level, it is not a health hazard, even for a developing fetus," Hulla said.

Mayer said that while the higher number "may be right for healthy adults ... with our charge of being protective, I think that's cutting it pretty close if not missing the mark altogether."

Drinking water providers agree they would rather err on the side of caution when it comes to providing the safest possible product to their customers. "There is one school of thought that consumers should not be concerned until science demonstrates a health risk," said Mark Beuhler, MWD associate vice president. "An alternative point of view is that consumers deserve full disclosure and should be able to make informed choices about the water they drink while scientific studies are ongoing. Metropolitan subscribes to the latter point of view."



Removing perchlorate from water is primarily done through ion exchange.

Perchlorate also has come under consideration for listing under the California Safe Drinking Water and Toxic Enforcement Act, also known as Proposition 65, which requires warning labels be posted for chemicals known to cause cancer or reproductive/developmental harm. In July 2002 environmentalists requested that perchlorate be listed under the Act. In December, a scientific advisory panel for OEHHA found that expedited research on the matter is warranted, with a report due in late 2003.

Groundwater

Sixty years ago, the outlying region of southern California was a hub of industrial activity as major companies propelled America's production of military hardware and the fledgling space exploration program. During that time, environmentally responsible management practices took a back seat to the higher priority of national security, leaving behind a legacy of contamination caused by several chemicals, including perchlorate. By the late 1970s, investigation into the extent of groundwater pollution revealed some truly astounding numbers. One well monitored by EPA in the San Gabriel Valley had levels of PCE at 8,900 ppb, thousands of times greater than the state drinking water standard.

One of the first references to perchlorate contamination occurred in 1957, when the Journal of the American Water Works Association reported on polluted groundwater in several California municipalities as a result of local underground disposal practices. In 1964, groundwater testing in eastern Sacramento County found perchlorate in 34 wells at levels as high as 18,000 ppb. Regulatory action was not taken because of the lack of knowledge about perchlorate, and because the wells were not sources of drinking water.

Perchlorate has contaminated groundwater in several areas throughout southern California.

Beyond the risk to public health, the impact of polluted groundwater has been near crippling to some communities, where tapping alternative water supplies is not an option. In the San Gabriel Valley and Inland Empire regions, about 189,000 acre-feet of water is unusable because of contamination, a substantial amount given the reliance on groundwater to sustain economic growth.

"Perhaps most relevant in today's era of water uncertainty ... is that groundwater contamination renders millions of gallons unusable every year," states a January 2003 report, *Down the Drain*, by Environment California. "At a time when California's water supply from the Colorado River has been halved and the specter of drought looms on the horizon, the need to protect our water supplies from pollution has never been greater."

Perchlorate contamination has affected several areas throughout southern California, from Ventura County to Rialto. In the San Gabriel Valley, home to several Superfund sites, the discovery of perchlorate in 1997 created a shock wave as regulators raced to identify the scope of the problem and an appropriate response. Williams recalled the reaction that accompanied the initial news of affected drinking water sources.

"We had to scramble as best we could because eight wells in the same general area were immediately taken out of service," Williams said. "It took a few years to line up alternative supplies and develop a treatment method, and for a while it sure created a problem. It's a little bit less of a problem now because we know where it is and we're building treatment plants."

While cleanup of perchlorate and other chemicals is ongoing, officials are faced with at least 50 wells out of service and the increase of expensive imported water. On top of that, during the past 20 years, public agencies have spent more than $85 million in unrecovered cleanup costs, according to *Down the Drain*. "While the ultimate cleanup costs have never been tallied, the current costs involved in cleaning up contamination in the San Gabriel Valley total over $390 million dollars," the report says.

Farther east, perchlorate contamination has caused a maelstrom of investigation, public hearings and accusation of liability in several cities in and around San Bernardino County. Since 1997, perchlorate contamination left over from industrial and defense-related activity has shut down wells in Colton, Fontana, Rialto and San Bernardino. Officials believe the responsibility for the contamination lies with Black and Decker, Kwikset, Goodrich, defense contractors and possibly a county landfill where the remnants of perchlorate remain. County officials have accepted responsibility for the pollution closest to the landfill and are complying with a cleanup order issued by the state.

Compounding the problem is the difficulty in trying to identify particular liability for contamination, a process the EPA's Mayer likened to "looking for a murder suspect at a butler's convention." Plumes that have migrated several miles throughout the past 40 years are sometimes nearly impossible to trace to individual sites, while records of manufacturing, if located, don't always tell a complete story.

Estimates are the region will experience a shortfall of 26 million gallons each day if immediate action is not taken to address the situation.

"One-third of our wells have shown levels from 4 to 14 ppb," said Bob Martin, general manager of the East Valley Water District. "We don't have the luxury of turning them off because we don't have a backup supply."

The wrangling over responsibility for the cleanup led U.S. Sen. Dianne Feinstein, D-Calif., to ask EPA to step up its efforts to identify and spur action by responsible parties. "Thus far, more than 60 percent of the funding to address cleanup has come

from state and local sources and only one private firm has agreed to contribute toward the cleanup," Feinstein wrote in a March 12 letter to EPA Administrator Christine Todd Whitman. "Clearly more must be done now to determine the responsible parties and require their immediate participation in cleanup efforts in order to avert potential water shortages this summer."

If there were a ground zero for perchlorate contamination, it would have to be the suburban Sacramento community of Rancho Cordova, home of an Aerojet manufacturing facility for more than 50 years. During that time, the company produced liquid and solid fuel for military and commercial rockets, and conducted extensive work on rocket engines. According to state water regulators, waste chemicals at the facility, including perchlorate, were regularly disposed of by burial, open burning, discharge into unlined ponds and injection into deep underground wells.

According to EPA, the disposed perchlorate formed into six underground plumes that were first noticed in the mid-1980s. After the more sensitive detection technology was discovered, it was determined that perchlorate contaminated 55 percent of the area's water supply. Currently, 11 drinking water wells in Rancho Cordova are closed due to contamination, enough water to provide more than 25,000 families for one year.

Aerojet's perchlorate plume was the subject of an investigative article in the *Wall Street Journal* that shed light on the conditions that produced the level of pollution found today. According to the report, beginning in the early 1950s, about 300 pounds of perchlorate would flow into an underground aquifer each day. Efforts by water quality regulators to control the discharge went unheeded, partly because the company believed the disposal of perchlorate into unlined pits left over from gold dredging pits constituted a safe and acceptable method.

Ladd said residents have been frustrated by an investigation and cleanup process they believe is controlled by the Pentagon and defense industry.

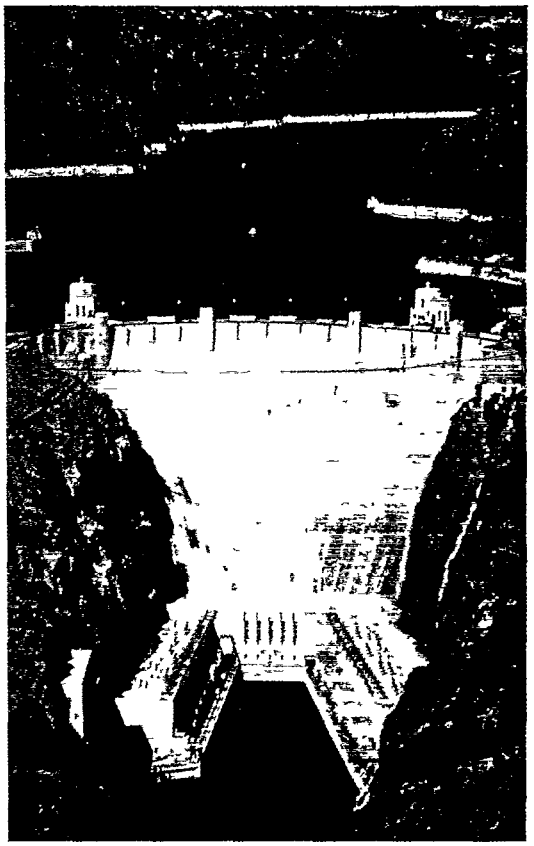
Trouble in the Colorado

Hundreds of miles from where it is drawn, water from the Colorado River helps slake the thirst of millions of Californians as well as growing the produce that feeds a nation. But along the way, a quiet invader that threatens the very integrity of the source has launched a comprehensive effort to stem the tide.

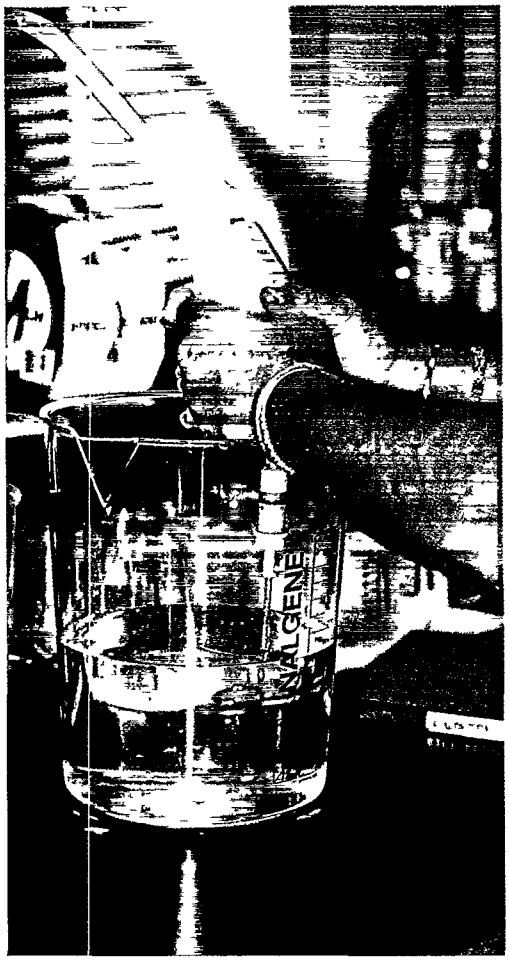
For decades, production of perchlorate took place just miles away from the Las Vegas Wash, a rugged stretch of land between Las Vegas and the river that serves as a conduit for drainage. As with other areas where perchlorate was handled, ignorance, indifference and carelessness resulted in widespread contamination of aquifers. In Henderson, Nev., the trail began with the U.S. Navy, which operated a facility in the 1940s. Following that, two companies, Kerr-McGee and American Pacific, continued production.

The hydrology of the Wash features a relatively shallow aquifer that actually surfaces at one point. The plume of contaminated water takes several years to travel the three miles from the plant site to the Wash. At its height, 1,000 pounds of perchlorate flowed into the aquifer each day. "Henderson is where the very highest concentration is," Mayer said, adding that the impact "gets to be pretty astounding" considering that Colorado River water serves the cities of Las Vegas and Phoenix in addition to MWD.

By 1997, the slow migration of perchlorate-tainted groundwater through the Wash and into Lake Mead began to be noticed by MWD, which counts on the Colorado River as one of its primary sources of water. Testing has indicated levels between 4-9 ppb. MWD, in response, has taken steps to blend its Colorado River supply with



Perchlorate has been detected in Lake Mead, formed by Hoover Dam, above, at concentrations of 4-9 ppb. The source was traced to the Las Vegas Wash, which empties into Lake Mead.



EPA does not expect to have an enforceable standard in place for perchlorate until at least 2007.

deliveries from the State Water Project, but "this is at best only a temporary solution," Beuhler said.

Initial relief has come through Kerr-McGee, which has installed control wells to intercept and treat the contaminated plume that enters the Wash. The most recent device, installed in October 2002, is expected to significantly reduce the concentration of perchlorate, said Doug Zimmerman, who heads the bureau of waste management for the Nevada Division of Environmental Protection. A line of extraction wells in a "fairly confined" hydrologic setting has managed to reduce the perchlorate load to 400-500 pounds a day.

"We're dealing with the Mother Lode right now," he said.

Water providers are optimistic the effort underway will diminish the scale of the problem and ultimately make it easier to comply with the new drinking water standard. "We should see a dramatic decrease, and six months later, the level should go down even more," said J.C. Davis, spokesman for the Southern Nevada Water Authority (SNWA). About one-third of the recent samples of river water below Lake Mead are below the detection limit, he said.

The MWD's Stewart said his agency is pursuing an "aggressive" modeling program designed to project the degree by which perchlorate will be removed from the plume. "We expect to see results probably in the early part of summer," he said. "We need to know that because right now, our only tool is to blend the water."

SNWA does not have the option of blending its water to dilute the perchlorate concentration and is looking at potential remediation processes. Although none has yet emerged, J.C. Davis is confident the problem can be overcome. "If you come up with a technological challenge, you're probably going to get some solutions," he said.

Zimmerman said the amount of perchlorate removed thus far, 763 *tons*, "boggles your mind" as to just how much the water has been polluted the past 60 years. "The best we can do at this point, as a result of the latest effort, is to expect to see the load drop to less than 100 pounds a day," he said. In the meantime, MWD and SNWA continue their operations in anticipation of the new standards to be promulgated by EPA and DHS.

"We don't know when there will be an enforceable standard ... and what it will be," J.C. Davis said. "What we believe is the ultimate solution is to cut off the source [of perchlorate] and let the lake and river cleanse itself."

Looking Ahead

Perchlorate's rather jolting appearance as a water quality problem has caught the attention of state and federal lawmakers, particularly representatives of areas hardest hit by contamination. "I do think we're at the point where the issue has really grabbed the attention of some of the more influential policy makers at the state and federal levels," Mayer said.

Feinstein has had repeated contact with the Defense Department and EPA, with the expectation of greater funding, investigation and assignment of liability. Sen. Barbara Boxer, D-Calif., has introduced legislation that would require EPA to have its drinking water standard developed by July 1, 2004.

"Perchlorate is a clear and present danger to California's public health," Boxer said in a written statement. "We can't wait four more years to address this threat. EPA needs to get moving and protect our drinking water sooner rather than later."

Later, Boxer sent a letter to Whitman in response to EPA's stance that the 2004 deadline for a perchlorate standard is not possible. "Not only is it possible, it is critically necessary to protect against the devastating effects of perchlorate on public health and water supplies," Boxer wrote.

"It's difficult to conceive how to do that without allowing EPA to finish the health effects studies," J.C. Davis said. "It's not an acute thing, it's chronic, and there's no shortcut for that."

He added that, "if the intent of the legislation is to spur a more ambitious cleanup effort ... we feel very good about our position."

The dispute about the degree of the public health threat presented by perchlorate led four federal agencies in March to ask the National Academies of Science to convene an expert panel to review EPA's assessment. The panel was to look at the most recent data on thyroid disruption; the accuracy of predicting the neurodevelopmental problems associated with altered iodide uptake; the degree to which an iodine-rich diet could influence the adverse effects on sensitive subpopulations and whether

EPA did not properly consider any key studies.

"I think the best way is to proceed with the NAS review, but to expedite it," said the Corps' Hulla. "Let's do the best science but let's not delay it."

California lawmakers have weighed in with bills that would set the MCL as close as is economically and technically feasible to the PHG. Soto has authored legislation (SB 1004) that would establish reporting procedures for the storage and discharge of perchlorate. In the meantime, areas hit by perchlorate contamination continue to grapple with expensive cleanup and treatment costs. The cost of importing water can run as much as $4,000 per day.

"Alternative water supplies are one of the better short term options but ultimately, in the arid Southwest, water is a limited commodity and just allowing a part of the resource to be unused ... is maybe not the best long-term solution," Mayer said.

The debate over standard setting brushes against the thorny issue of enacting public policy with thorough and complete science, as well as the economic feasibility alluded to in DHS' maximum contaminant level. "At EPA we try to be objective [but] we are also in charge of managing risk," Mayer said. "The drinking water standard must take into account the cost benefit of setting a standard of as low as we want to go."

MWD's Stewart said the process of setting a regulatory standard "is always complicated" because while there is the need to direct "due diligence" to the scientific research, there's "also the desire to get the issue moving forward, so I appreciate that. We'd certainly like to see some clarity."

"Arsenic is the best understood [contaminant] for health effects, while the data on perchlorate is highly disputed," he said. "There's still a lot of science people would like to review and discuss."

Indeed, establishment of a drinking water standard at the low end of EPA's scale would not be viewed as an insignificant regulatory development. "Millions of people depend on the Colorado River for their water supply and to have that out of compliance would be frightening," said Professor Hunt. There is expectation, however, that through current cleanup efforts and resumption of improved flows through the river, perchlorate will become less a problem.

"I'm guardedly optimistic we'll capture the vast majority of perchlorate," J.C. Davis said. "When will we be at non-detect? I don't know."

As the regulatory process unfolds toward the setting of a drinking water standard, the uncertainty over the threat posed by perchlorate and the appropriate response lingers. The scientific research will continue even after EPA and DHS arrive at what they believe is the most protective number, based on all available evidence. Even so, Mayer said it is important for people to understand the relative risks that are involved with living in the modern world.

"Science can take us so far but it will not give us every answer for every human being everywhere," he said. "Society needs to make policy decisions. Is [setting a standard] something we want ... or need to do." ❖

"At EPA we try to be objective [but] we are also in charge of managing risk. The drinking water standard must take into account the cost benefit of setting a standard of as low as we want to go."

—Kevin Mayer
U.S. EPA

For More Information

EPA Ground Water and Drinking Water
http://www.epa.gov/safewater/ccl/perchlorate/perchlorate.html

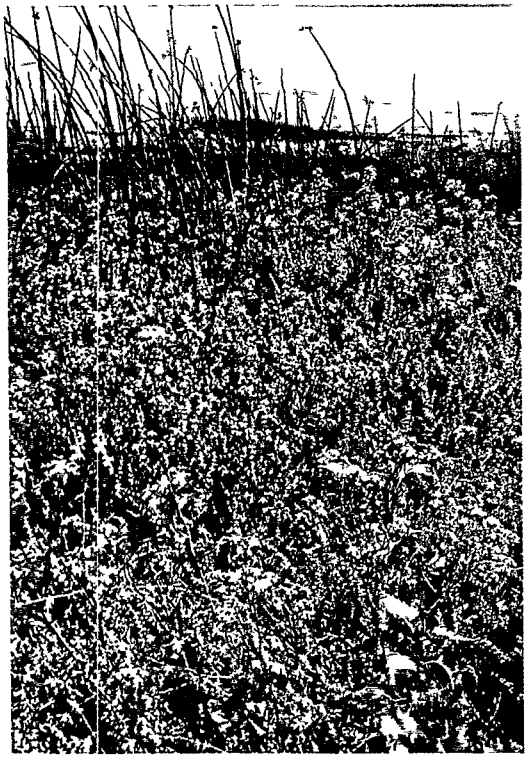
EPA Technology Innovation Office: Perchlorate Remediation Resources
http://www.clu-in.org/perchlorate/

DHS Perchlorate in California Drinking Water—Status of Regulations and Monitoring Results. http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/perchlindex.htm

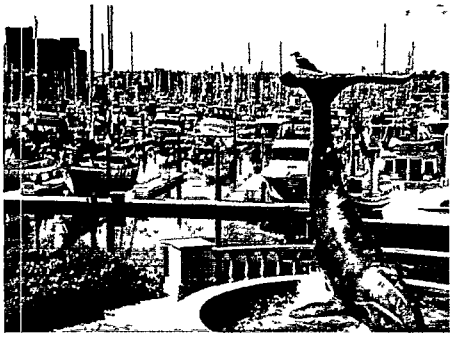
DHS Drinking Water Action Level for Perchlorate. http://www.dhs.ca.gov/ps/ddwem/chemicals/perchl/actionlevel.htm

OEHHA Draft PHG for Perchlorate in Drinking Water, Dec., 2002. http://www.oehha.org/water/phg/pdf/PHGperchlorate120602.pdf

OEHHA Perchlorate Fact Sheet.
http://www.oehha.org/public_info/facts/perchloratefacts.html



The Bay-Delta Tour includes a stop at Suisun Marsh, above.



The July 17-18 Water Law & Policy Briefing will be held in San Diego.

What's New

Tour the Delta

All roads in California water policy lead to the Bay-Delta, source of two-thirds of the state's water and home to a rich ecosystem of fish and wildlife – including many endangered species.

The Foundation's popular **Bay-Delta Tour, June 4-6**, offers you the chance to see this important region firsthand. Tour stops include the Delta Cross Channel, the State Water Project fish screens, Los Vaqueros Reservoir, a state-of-the-art water treatment facility, the Bay-Delta Model in Sausalito and Suisun Marsh. Speakers from a wide variety of viewpoints address everything from water project operations to endangered species to drinking water quality to the CALFED plan and the new California Bay-Delta Authority.

Delta tour sign-ups are underway. Call the Foundation, 916-444-6240, to request a registration form, or register on-line at www.watereducation.org

Water Law and Policy Briefing

Planning is underway for the Foundation's **2003 Water Law & Policy Briefing**, to be held **July 17-18** at the Hyatt Regency Islandia Hotel in San Diego. This briefing is designed for lawyers, water managers, government officials, business executives, public interest groups and others interested in key water issues. Topics to be discussed include the Colorado River, Klamath River issues, groundwater storage rights, water quality issues and the Bay-Delta. **California Attorney General Bill Lockyer will be a featured speaker.**

Registration for the event is $350 for Foundation major contributors; $400 for non-contributors; $425 late (after July 10) and on-site registration; $275 for July 18 only. Registration fee includes a full set of Layperson's Guides, a complimentary school program, and lunch and a hosted reception on July 17 recognizing attorney Jess Senecal for his contributions to water law. (This activity has been approved by the State Bar of California and attorneys who attend both days will receive 10 hours of MCLE credit.)

Watch our web site, www.watereducation.org, for a full agenda. Or call , 916-444-6240, for more information.

New Water Facts Brochures Available

Several new water facts brochures are now available from the Water Education Foundation.

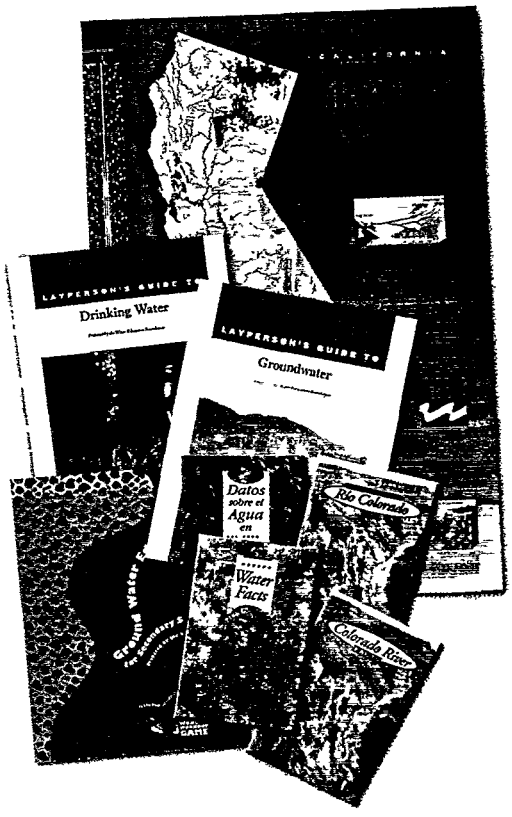
The 12-page **Nevada Water Facts** brochure provides an overview of the state's sources of water, use of water, and need to conserve water. Development of this brochure was funded by a grant from the U.S. Bureau of Reclamation, Mid Pacific Region, Lahontan Basin Area Office. Individual copies are 20 cents each.

The new 24-page **Colorado River Facts** brochure gives the reader information about the history of this multi-state, multi-use river – and an overview of today's pressing issues. It is also available in a Spanish version, "Información Sobre El Rio Colorado." Development of this brochure was funded by a grant from the U.S. Bureau of Reclamation, Lower Colorado Region. Individual copies of both booklets sell for 55 cents each.

Also now available is a new Spanish version of our popular 12-page California Water Facts brochure. "Datos sobre el Agua en California" provides a quick overview of the state's water supply, projects, environmental issues and water conservation issues. Individual copies are 20 cents each.

Priced to give away at community events and meetings, or to water district customers, **bulk order discount prices are available** for all these brochures. They also can be personalized with your agency's/organization's name. Call the Foundation, 916-444-6240, for more information. ❖

Groundwater/Water Quality Materials



Item No. 4010 May/June 2003 *Western Water*, "Confronting a Legacy of Contamination: Perchlorate," $3.00 each

Item No. 4000 Yearly subscription to *Western Water*, a bimonthly magazine, $40.00

Item No. 4560 *Layperson's Guide to Drinking Water*, 24-page guide, updated and reprinted in 2002, $7.00 each, ($5.00 each for 10 or more – Item No. 4560.1)

Item No. 4620 *Layperson's Guide to Groundwater*, 20-page guide, NOW BEING UPDATED! Order yours today – will be shipped in approximately one month, $7.00 each, ($5.00 each for 10 or more – Item No. 4620.1)

Item No. 2030 California Groundwater Map, 24 by 36" poster, $10.00 each ($7.00 each 10 or more – Item No. 2030.1)

Item No. 6004 Groundwater Quality: Managing the Resource, 15-minute VHS video that explains issues surrounding groundwater quality, $20.00 each

Item No. 5000 Groundwater Education for Secondary Students, grades 7-10, 52-page teachers booklet with lessons about groundwater quantity and quality, $25.00 classroom set

Item No. 4705 Nevada Water Facts Brochure, 12-page booklet that provides quick overview of Nevada water, 20 cents each

Item No. 4707, Spanish California Water Facts Brochure, Spanish version of 12-page California Water Facts Brochure, 20 cents each

Item No. 4703 Colorado River Facts Brochure, 24-page booklet that provides readers with information about the Colorado River – its history and modern issues, 55 cents each

Item No. 4704 Spanish Colorado River Facts Brochure, Spanish version of 24-page Colorado River Facts Brochure, 55 cents each

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